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Collective irrigation, the state and social relations in the Eastern Pyrenees of France

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Abstract

In this article, we consider the social effects of a large dam in the Eastern Pyrenees region of France. In 1976, the French state constructed a dam near the town of Vinça on the Têt River, altering the hydrological conditions that had co-produced a complex system of hydro-social relations evolved since the Middle Ages. We argue that through altering the relative proximity of dependencies between farmers and between farmers and the state, the dam has had the effect of transferring expertise and social power from local to central authority. However, this shift is made difficult by the evolution of local farmers associations to take advantage of the new hydrological circumstances produced by the dam. The production of hydrological certainty assured by the dam has changed the raison d'etre for these associations (known as Association Syndicale Autorisée), providing them with new opportunities such as in the development of pressurized drip irrigation. In these circumstances, the relations between the Association Syndicale Autorisée and the state produce a hybridized authority over water, neither quite centralized nor local but combining both. We draw from Bookchin's elaboration of 'post-scarcity anarchism' as well as Bouba-Olga and Grossetti's concept of proximities to describe the pitfalls and the promises of pressurized irrigation in the region, made possible by the dam.

Keywords

Water, water governance, technology, spatial justice, structural power

Introduction

The Roussillon plain, located in the Eastern Pyrenees Department of France, is an ideal area to study the collective management of water resources by virtue of its long history of community management of irrigation. Notably, recent momentous changes in the physical

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availability of water have impacted these management practices. Located in the Mediterranean region, along the Spanish border, the area displays hydrological and climatic conditions that have played an important role in the emergence of historical irrigation networks (Jaubert de Passa, 1821: 261), which partially remain in place until today. The local economy is closely tied to them. Today, as in the past, water is key to agriculture in this region, and one has to view agriculture as inseparable from water (Ruf, 2001).

While the Mediterranean climatic conditions could be said to determine the necessity of irrigation, particularly for the cultivation of fruit and forage, which have been the outstanding products of the region, the specific form that irrigation has taken is unique to the region. Here, producers have long adopted local, decentralized structures to manage irrigation. Jaubert de Passa (1821) identifies these as typical of border regions that have been affected by historical invasions and political uncertainty, in the sense that the influence of the state has been historically weak in this region.

In this article, we subscribe to Wittfogel's (1957) notion that irrigated agriculture has important implications for social relations, and for the geometry of social power. France is no exception to the association evident in many countries between the growth of the modern state and the control of water. As described by Rosenthal (1990), between 1700 and 1860, a strategy of the French state was to gain territorial control under cover of water management. More recently, over the past 40 years, the French State has expanded its role in the Eastern Pyrenees region, directly and indirectly, through the construction and operation of hydraulic infrastructure. These moves however have taken place in the context of a rich heritage of local control of water and a deeply entrenched hydro-social structure of collective control of canal irrigation. The outcome, as we argue, has been the hybridization of central and local rules, structures and cultures of water. The major historical rupture for farmers in the region – the construction of the Vinça Dam in the 1970s – can be seen as a means of bringing modern agriculture to the Plain (Mendras, 1967), and as a means by which the French state has gained increasing control over land and people. Nevertheless, throughout this period, local associations of farmers have struggled to retain a measure of authority over water resources. The result has been a continual tension between the central state and local farmers and farmers' collective associations over the rule of water in the region.

This article considers the implications of the dam for the social fabric of collective water management that has long characterized the Eastern Pyrenees region. The dam produces what we call 'hydrological certainty', which can be defined as an assurance that certain volumes of water are guaranteed to be available to farmers and farming collectives at specific times in order to facilitate production. The guarantee of certainty provided by the dam alters the conditions that had produced the need for collective management to deal with the long-standing condition of hydrological uncertainty, in which farmers were uncertain of the volume of water supplies available in the summer to support irrigation.

The article pays particular attention to the role of the 'Association of Canals Below the Vinça Dam' (l'Association des Canaux en Aval de Vinça, ACAV), which combines several canal-management and irrigation associations, known as ASAs (Association Syndicale Autorisée) downstream of the dam. After describing the geographical and historical context of the region, our aim is, firstly, to explore the effect of the state-led production of hydrological certainty on the social structure of the ASAs while emphasizing that the fragmentation of social space by decentralized irrigation systems has worked against the imposition of hydraulic society in the region. Secondly, we will analyse the social effects of a further technological change made possible by the dam and heavily promoted by the state, namely transition to pressurized and drip irrigation.

We propose, on the one hand, to carry out an analysis consistent with what Aubriot (2013: 125) describes as a 'revealing of social relationships through the study of irrigation'.[1] This is an analysis consistent with the notion that the structure and practice of irrigation mirrors social relations (Aubriot, 2004). On the other hand, we subscribe to a dialectical approach, which holds that, while irrigation is a social construct, the material structure of an irrigation system equally affects social relations (Bichsel, 2016: 356; Wittfogel, 1957: 22). Overall, we describe how the Vinça Dam and the advent of pressurized irrigation have contributed to an historical shift, by introducing what could be described in terms of 'modern water' (Linton, 2010) in the Eastern Pyrenees, as well as the resistance put up by local farmers to this move, with the result of producing hybrid waters.

To better understand the social implications of the construction of the Vinça Dam and the installation of pressurized irrigation in the region, we further draw on the concept of 'proximities' (Bouba-Olga and Grossetti, 2008; Torre and Filippi, 2005). A concept that relates the spatial dimension of economic activities with social relations and networks, 'proximity analysis' makes a basic distinction between geographical (or spatial) proximity and the effective proximity of human actors and technical objects in a socio-economic relationship. A further distinction is made between the proximity (or coordination) of human actors involved in a social structure or network and the organizational, knowledge and technical capacity of people to exploit resources (Figure 1).

Starting from the hypothesis that the spatial location of actors in a network is a key determinant of the functionality of the network, the quality of social relations and the nature of collective action, we consider the effects of the transformation in type of proximity associated with the shift from gravity to pressurized irrigation. Indeed, the close spatial proximity (between farmers – as proximity of coordination – and between farmers and water – as proximity of resources) associated with gravity irrigation was radically transformed to a socio-economic proximity involving water only in its agronomic properties and reducing the interactions between farmers and between farmers and water.

Finally, building on Wittfogel's argument that hydraulic society did not take root in Europe due to feudal fragmentation (Murdock, 1957), we draw on the writings of M Bookchin, who reads feudalism in a more positive light of resilience against central authority. Bookchin claimed in 'Post Scarcity Anarchism', published in the 1970s, that the abundance, as well as the potential for liberation, created by new technologies opened up possibilities of local development (social, economic and environmental) that were hitherto inaccessible.

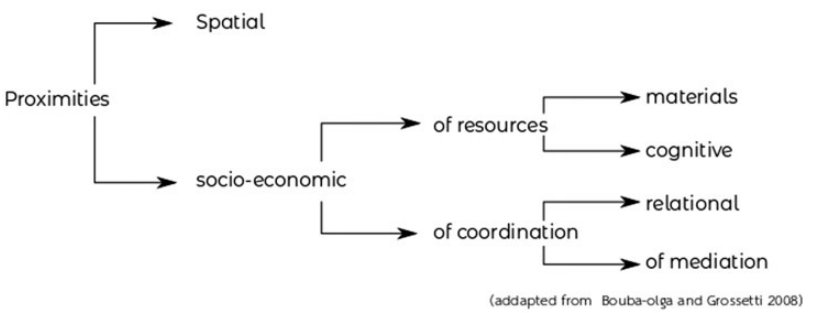

Figure 1. Different types of proximites. Adapted from Bouba-Olga and Grossetti (2008).

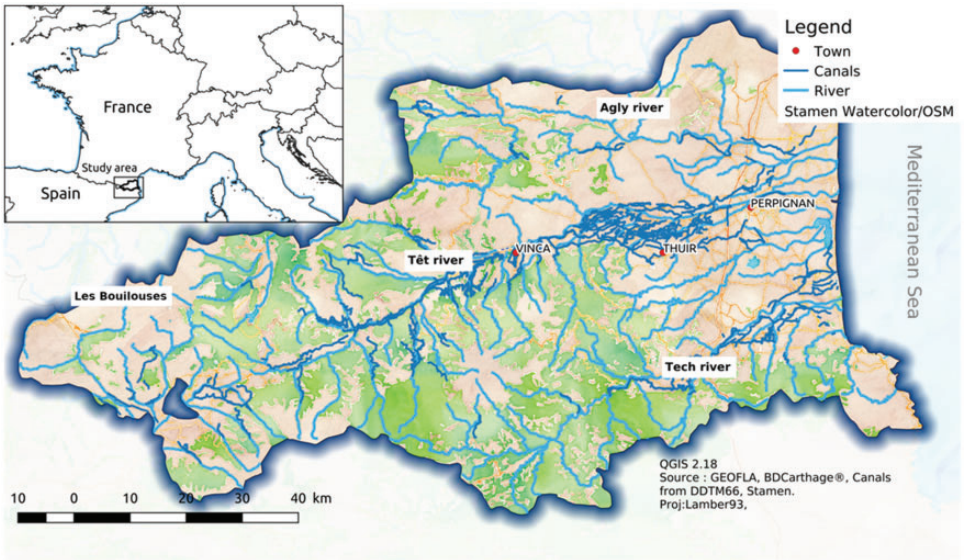

Figure 2. Study area map.

Geographical context

This study is based on research undertaken in the Roussillon plain, specifically the area between the Vinça Dam to the east, the Corbières mountain chain to the north, the Mediterranean Sea to the west and the Albert mountains to the south. The study focusses on the basin of the River Têt (Figure 2). The Têt is 115 km long, with a catchment area of 1369 km^2 and 43 identified tributaries. Its source is at the foot of the pic Carlit, at an altitude of 2405 m. There are two main dams in the Têt basin: the Bouillouse Dam (17 million cubic meters) built in the first decade of the twentieth century and the Vinça Dam (24 million cubic meters) constructed in the 1970s.

From a climatic point of view, the region is characterized by a Mediterranean climate, essentially temperate, with a dry season in summer and an average temperature for the warmest month of over 22°C (Peel et al., 2007). Average annual precipitation is 557.6 mm and average annual temperature ranges between 11.4°C and 20.1°C (http://www.meteofrance.com/climat/france/perpignan/66136001/normales).

From the temperature-precipitation diagram (Figure 3), we can see there is scant precipitation over a period that can extend from May to September.

Historical context

The history of canals in the region begins around the ninth century, when Muslim invasions brought canal technologies to Roussillon. According to M Jaubert de Passa (1821: 53), this was

> the most interesting period of history of the Roussillon; since it was then that in acquiring franchises from its sovereigns and encouragement from its noblemen, this province rose, thanks to its industry and its commerce, to the ranks of power. The inhabitants of the countryside breathed/lived in the shadow of the liberal towns and a permanent bourgeoisie.

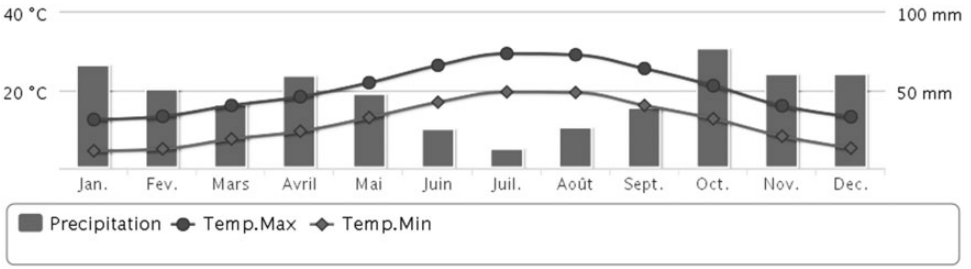

Figure 3. Temperature and precipitation in the Eastern Pyreneees (Météo-France, 2016) for the period 1981–2010.

Consistent with Wittfogel's framework, political power in this region was exercised by a centralized authority through its local agencies. Initially, local political and economic power was based on the application of water power to industry (milling and textile production) that was owned privately (seigneuries, abbeys and leaseholders). The canals were, however, owned, managed and maintained by groups of property holders organized as associations or syndicates (Ladki et al., 2012: 28). Irrigation, although present in the first millennium, began growing in importance – initially as a secondary use of water from the canals – in the twelfth century. It became the primary form of water use by the eighteenth century when the industry declined, while viticulture grew in importance. By the nineteenth century, viticulture was predominant, and the industrial use of the water disappeared completely (Ladki et al., 2012).

At the beginning of this period, the region Catalonia was attached to the Kingdom of Aragon. While it was part of the Kingdom of Majorca from 1262 to 1344, it later fell back into the hands of the Kingdom of Aragon. In the seventeenth century, French Catalonia returned into the sphere of influence of the King of France. Throughout all these constitutional arrangements, the customs, laws and rights regarding the collective management of canals and irrigation remained fundamentally unchanged and were 'confirmed by official declarations' (Jaubert de Passa, 1821: 261). The draft of the new Civil Code which appeared at the time of the French Revolution included in article 645 the introduction of respect and 'maintenance of particular and local regulations of watercourses and the use of water' (Jaubert de Passa, 1821: 262). Thus, the basic pattern of collective ownership and management of water in the region withstood numerous external changes. This basic rule of 'self-managed' and 'community' irrigation systems persisted through the nineteenth century, notwithstanding various constitutional adventures and changes within French law (Ruf, 2009). By the law of 21 June 1865, the state codified these arrangements, creating a legal entity called the Authorised Syndicated Association (ASA) and conferring on them the status of public agency or institution (*établissement public*) (the structure of ASAs is further described below). This was followed by considerable expansion of gravity-based irrigation networks throughout the region (Ladki et al., 2012: 29).

The next major expansion of irrigated agriculture in the region occurred in the first half of the twentieth century. The Roussillon plain in the Eastern Pyrenees quickly became the vegetable garden of France, providing the country's population with agricultural produce well in advance of other French regions. This national 'dependence' on agricultural products from the Eastern Pyrenees Orientales region was highlighted when the 'great flood of October 1940' (Pardé, 1941) temporarily caused a halt in production, driving up the price of produce. Léon-Jean Grégory used this as an argument for the construction of the dam as

part of his bid for a seat in the French Senate. He served as a senator from 1948 to 1979, promoting the dam at the highest levels and eventually overseeing its completion in his final term of office. The prospect of a dam in the locality of Vinça had been discussed well before Grégory came on the scene. At that point, hydraulic society in the region remained fragmented, which the state (and Grégory) regarded as an obstacle to modernizing agricultural production. The first step in the modernization process required the reduction of uncertainty of water supply through the building of the Vinça Dam. The changes induced by the construction of the dam had the effect of opening up the possibility for farmers to have water availability all year long, and it became economically viable to install pumping stations along the canal and therefore to pressure irrigation. Prior to the dam, the frequent occurrence of water shortages in the main canals during the dry summer months discouraged the adoption of this expensive technology.

During the same period, the French Mediterranean coast became attractive to tourists as well as French people who sought to establish themselves here. This gave a new sense of importance to flood control, especially with the memory of the 'great flood' still fresh in the minds of local officials, thus underscoring the rationale behind the dam (Ladki et al., 2012).

The Vinça Dam[2]

As already noted, the idea of constructing a dam for the Roussillon plain on the Têt River in the commune of Vinça was not new. In the 1930s, it had already been put forward in a pre-study report ordered by the General Council of the Department of Pyrénées Orientales. However, as noted, the flood of 1940 and the post-war economic climate obliged the Department to review its priorities. Thus, in 1953, the General Council asked for new studies for the project, and in 1965, the SOGREAH (Société Grenobloise d'Etude et d'Application Hydrolique) produced a preliminary report which was based on the conclusions of previous studies but proposed a different type of dam, in keeping with technical advances in the field. The dam would create a reservoir of 24 million cubic meters, which would improve irrigation while reducing the impact of floods and providing drinking water for urban and rural communities downstream of the dam. In our view, the most salient product of the dam was what we call hydrological certainty – an assurance that certain volumes of water would be available to farmers at specific times in order to facilitate production. This was to remedy the circumstances of hydrological uncertainty – with respect to the availability of water – that had hitherto pertained to farming in the basin. The SOGREAH study report is quite clear on this subject:

> [...] one of the major interests of such a reservoir, [...] will allow, by its very situation, the enhancement of the natural flow of the Têt during the period of water extraction, that is to say usually from the 1st July to 30th September. Currently, in the absence of such a reservoir, at the very origin of the large canals, any short-term influx of water caused by local storms in the Canigou or the Madrès mountains, which is produced in such periods, is to a large extent lost for the irrigators. The Vinça reservoir-dam will accumulate the excess of this influx to then release it on demand. [...] Furthermore, it is conceivable that the creation of the reservoir will not only improve the irrigation conditions in surrounding areas already equipped, but also irrigation in areas that do not currently benefit from irrigation. (Ref. 1388w12, part C, document no. 2 'Retenu de Vinça – Description Générale des Travaux – SOGREAH')

The perceived necessity of a dam was based on the juxtaposition of unprecedented demand for water of 'natural' supply, so as to produce a certain type of scarcity:

> To illustrate the imbalance between needs and resources, we cite two figures: [the figure] of 14 m^3/sec which corresponds to the 'water rights' of the syndicate associations and [the figures] of 5.5, 2.4, and 4 m^3/sec corresponding to the average flow rates at Vinça in July, August and September [respectively], taking into account discharges from the Bouillouse dam. [It is] understood that the real flow rates during periods of drought fall significantly below these values.[3]

The positioning of the need for the dam in favour of agriculture strongly reflects the political stance of Senator and Mayor of Thuir, Léon Jean Grégory, who shared a very clear vision of water distribution in the Department: the surface water he felt was to be reserved for agriculture, while the groundwater was to be dedicated to the provision of drinking water. The dam was therefore assigned to flood management (especially in spring) and in support of irrigated agriculture during the summer. The financing of the dam reflects this distribution of perceived benefits: The Ministry of Agriculture contributed 45% of the cost and the Ministry of the Interior 5%, with the remaining 50% being covered by various grants and loans made to the catchment area agency.

The mode of operation of the dam (Magali Rougé, 2015, personal communication) was, and still is, divided into three periods that we can cross reference with Figure 3:

- 1st January – 30th June: period of filling of the reservoir. During this time, only 3 m^3/second is released to the Corbère Canal below the dam, with the caveat that this outflow cannot be greater than the inflow to the reservoir.
- 1st July – 30th September: period of drawing water down for agriculture. The reservoir is drawn down to the minimum level, and the flow rate (to the river) at the dam is regulated to match the river's inflow to the reservoir. In case of low inflows, farmers' water rights are curtailed in order to conserve water in the river.
- 1st October – 1st January: period of almost complete emptying of the reservoir in order to provide a buffer for floods.

This formalized quantification of flows of water is one aspect of what has been described as 'modern water'. As Linton and Budds (2014: 111) have noted,

> Modern water is conducive to a style of hydrosocial relations that is reflected in the idea of 'water resources' and the practice of 'water management': it is characterized by a particular way of representing water, a particular kind of hydrological expertise, a concentration of control in agencies of the state, and a way of defining and approaching many water problems that orients attention toward augmenting water supplies.

A characteristic of modern water is the transfer of management and control of water from local authorities (farmers) to the state. The control of water and the growth of the modern state is indeed a common theme in much critical water scholarship. As Swyngedouw (2015: 30–31) notes,

> ever since Karl Wittfogel's seminal book on *Oriental Despotism* and his … analysis of the relationship between socio-ecological practices in arid and semi-arid environments on the one

hand and the nature of the despotic hydro-state on the other, research has proliferated on the close articulation between state formation and state structure on the one hand and the nature of hydro-social interventions on the other.

The dam as the cutting edge of agricultural modernization in the Têt basin

The second half of the twentieth century was marked by the transformation of irrigated agriculture in the area (Figure 4). The construction of the dam represented strong political (state) support for the agricultural sector, which experienced a golden age in the post-war period. The southerly climatic conditions of the region allowed it to position itself as a reliable early provider of fruit and vegetables for the French market. At a time when supply-side thinking still predominated water management, the dam was an obvious solution for those who sought to secure and expand production. However, as we now know, 1979 was at the tail end of the supply-side paradigm, and a new demand-management paradigm of water management began to take form in many developed countries in the mid-1980s. As a result of diminishing returns of water-supply investments, combined with growing concerns for protecting aquatic ecosystems, the French state gradually transitioned from efforts to augment water supplies to efforts to manage (reduce) water demand – by increasing water productivity – in agriculture and other sectors, often by applying economic instruments to water management. Thus began a shift in perception, whereby the farmers of the Eastern Pyrenees regions went from being regarded as efficient producers of a product of national importance, to profligate users – even wasters – of a scarce resource, for a product that was to become increasingly uncompetitive in the context of economic globalization.

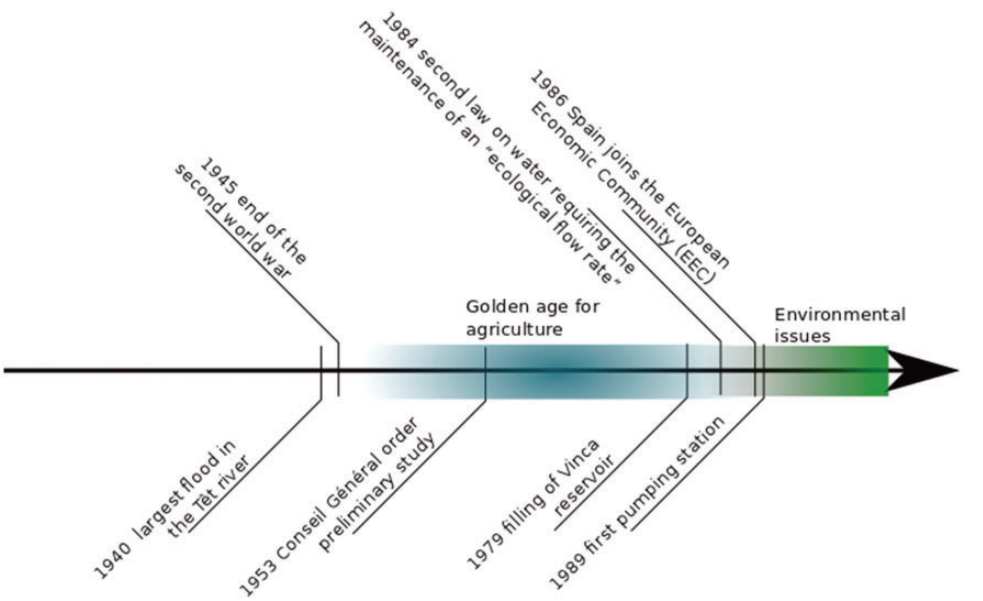

Figure 4. Chronology of irrigation and related events in the Eastern Pyrenees in the second half of the twentieth century. (Colours represent the transition from an era when agricultural production was paramount to an era when environmental protection grew in importance.)

This change of paradigm occurred in conjunction with the entry of Spain into the European Economic Community in 1986, which immediately had the effect of radically driving down prices for fruit, which was the mainstay of agriculture in the Pyrénees Orientales. Thus, people working in the agricultural sector faced a double bind: both growing environmental restrictions (minimum flows to protect aquatic habitat were first legislated in France in 1984) and new international competitors. As is often the case, the answer was the automation of production processes: irrigation was to gradually change from gravity-fed systems to pressurized, drop by drop systems. Indeed, for farmers below the dam, once a parcel of land is equipped with drip irrigation technology, irrigation becomes simpler and more individualistic, substituting manipulation of a system of electrical valves for coordination with the practices of one's neighbours. Farmers are no longer dependent on each other and their relationship with water is mediated by the ASA pump.

Institutional organization of the ASAs

The ASAs are the formal organization of water management in the Eastern Pyrenees. This type of institution groups together the landowners of a given area. The ASAs use a form of management by representation, where the 'members' elect a committee – the trustees – from which a president, a treasurer and a secretary are elected. The ASAs are the means by which collective irrigation is organized in the Eastern Pyrenees. In this article, we argue that shift from hydrological uncertainty to hydrological certainty in this region is evident in the evolution of the structure of, and techniques employed by, the ASAs: they have evolved from collective systems of mainly gravity-based irrigation to increasingly pressurized systems.

ASAs are considered 'public administrative institutions', which makes it possible for them to levy taxes that go towards the organization's budget. These charges are levied against landowners within the perimeter of the ASA and vary according to the type of water connection. For example, farmers with a traditional, gravity-based connection to the system pay proportionally less than those connected to the pressurized system.

The operations of each ASA are governed by statutes, which are left to the discretion of the local actors. An ASA is therefore a hybrid organization that originates locally, but which has fundraising mechanisms that are supported by the State. The processes for decision making can vary from one ASA to another. In some cases, each member has a vote, whereas in others, the ASA has chosen a more complex system of representation. For example, the ASA of the Canal de Corneilla Rivière has put in place a means of representation linked to the size of a member's irrigated area. Owners of between 0.15 and 2 hectares have one vote and owners of over 2 hectares have two votes. For the ASA of Pezilla, members have one vote per hectare owned. The ASA of Corbère has chosen a combination of the previous two systems: owners of land between 0.15 and 1 hectare have one vote. Owners with more land have one vote per hectare. The maximum is 10 extra votes per member.

Over the last several years, there has been a gradual shift from one person/one vote towards a system where the number of votes a person has depends on the size of their property. This shift from a kind of egalitarian, shared decision making towards a more concentrated form of decision making within the ASA is an institutional effect of the process of shifting from gravity to the pump. This institutionalization reduces what is described above as the coordination proximity. In effect, the ASA board of directors now makes decisions on its own without having to engage the full membership in the process. According to H Vidal (the president of the ASA at Vinça), the objective is to 'conserve the management of the ASA by the farmers' in the wake of the arrival of the so-called 'neo-rurals'. These people have acquired property in the irrigated areas. The question of

taxes has changed in recent decades, reflecting these changes within the ASAs. With more and more landowners representing residential (non-agricultural) interests, some ASAs no longer request payments from these non-agricultural landowners. E Maillol is the president of the ASA of Corbère and has been involved in local and regional water management since 1974. In an interview in 2016, he confirmed that 'taxes are often forgotten today, whereas 40 years ago this would not have happened' (2016, personal communication).

While there is an influx of ex-urban residents to the region, there are very few new farmers arriving to buy the lands made available by retiring farmers, which results in expansion and consolidation of farm holdings. According to E Maillol, drip irrigation facilitates consolidation because there is no longer any need to take into account the canal as a means of structuring territory. Drip irrigation, i.e. pressurized irrigation, removes the role of the secondary canal in structuring spatial relations within the ASA. In this context, agricultural activities, in addition to the obvious role of food (or fibre) production, also have a number of other functions such as governing natural resources, maintaining landscapes, conserving biodiversity and making a large contribution to the socio-economic viability of rural areas (Renting et al., 2009).

The spatial structure of irrigation and the farmers' perspective

In this section, we consider the social structure of irrigation in the region. We focused our attention on irrigation collectives organized at the scale of the ASA. In 2010, the Department of the Eastern Pyrenees was second only to the Hautes Alpes Department in having the highest number of ASAs in France (Figure 5). Both these regions are at great distance from the political centre of France. Moreover, they are located in mountainous terrain, i.e. geographically isolated, which contributes to the decentralization of water management in such places, consistent with Li's (2014) argument about the links between geography and centralization. Historically, the ASAs operated within spatially identified perimeters, with water being shared between ASAs along a main canal, which itself is maintained by the member ASAs. It is not unusual to find several ASAs organized sequentially along a main canal. Each ASA makes use of, and collectively manages, a secondary canal or canals, with individual farmers responsible for maintaining the canal abutting their property.

Watering of parcels of land in this region is traditionally carried out by gravity-fed, furrow irrigation. This method, still used in many parts of the world, involves hollowing furrows into the soil to allow the water to irrigate the land evenly and effectively. Management of irrigation time plays a fundamental role in the sharing of water, whereby irrigators 'take their turn' to open the valve on their plot to let the water inundate the parcel. This spatial organization corresponds to a pattern of social organization and produces dependence, as farmers located further downstream on the secondary canal rely on those upstream. Turning on and monitoring the water requires farmers' presence on the land and necessitates both informal and formal negotiation between neighbours along the length of the canal. One can well imagine the tension that can arise if a farmer's turn to access the water is delayed. This highlights the need for open and informal communication between farmers who share an irrigation network. Such communication facilitated informal arrangements and agreements between members of the networks. In an interview, R Majoral, President of the ASA of the Thuir Canal, spoke of such local arrangements: for example, a neighbour upstream would close their valve 10 minutes before the end of their turn to allow (sufficient) water for their downstream neighbour.

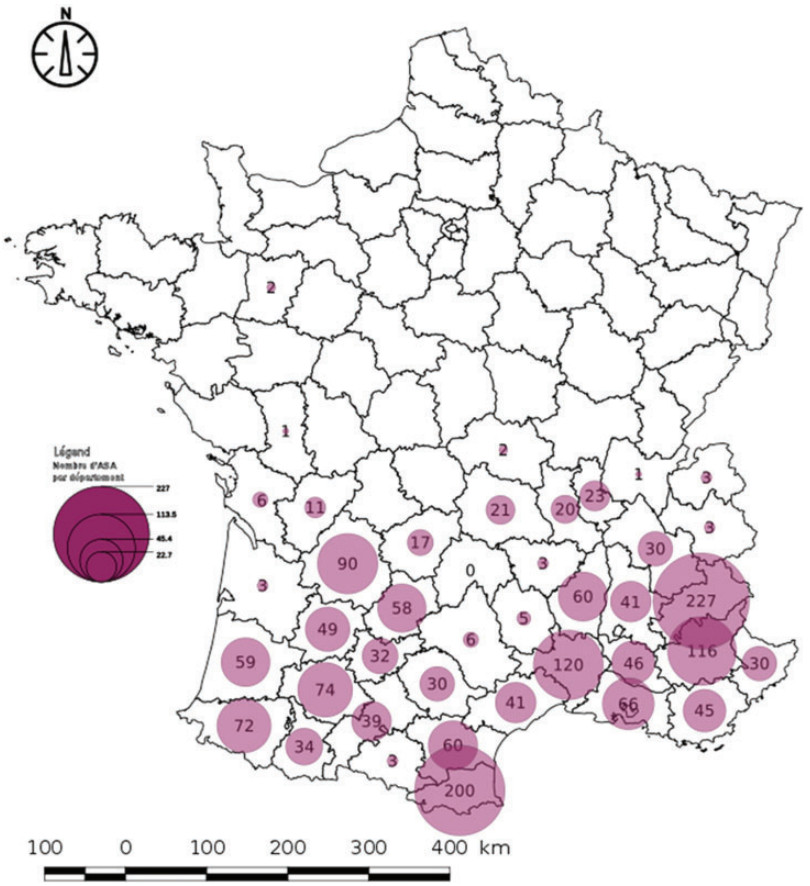

Figure 5. Map of the ASAs in France by Department in 2010 (Source: ASA info-service, map produced by E Delay).

The operation of the Vinça reservoir after 1979 effectively ended the uncertainty of water supply for farmers below the dam. According to R Majoral, it was often the case before the construction of the dam that 'in the month of July, when water levels were at their lowest, there was not a drop of water' (2016, personal communication). Nevertheless, it was the uncertainty of summer supplies that was most problematic to farmers. Today, water is guaranteed to flow in the canals below the dam all year round and thus 'the younger generations have never experienced shortages' (E Maillol, 2015, personal communication).

The most significant change, however, came with the installation of pumps and areas of pressurized irrigation, which allowed irrigation by sprinklers and drop-by-drop systems. To function correctly, the pumps needed to be fed continuously with water, a condition that the dam guaranteed. The first pumps downstream of Vinça were installed in 1989 in the ASA de Corbère area, according to E Maillol (2016, personal communication). The installation of pressurized and drip irrigation radically changed the spatial configuration of the irrigation network. It developed from a branched structure, intrinsically reflecting upstream–downstream dependence, to a star-shaped network, which changes the structure of interaction between farmers (Figure 6). The relationship from one person to another is now mediated

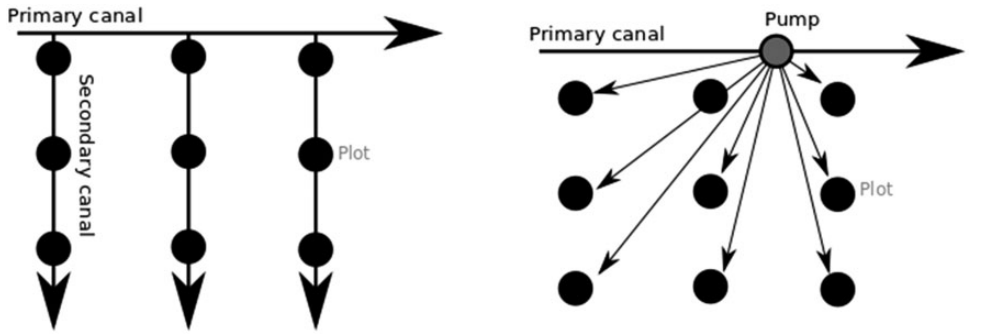

Figure 6. Two patterns of social relations structured by irrigation: The figure on the left represents the traditional gravity based system – on right, a pressurized system.

by the ASA pump rather than by the secondary canal, with the effect of individuating farmers.

In the Pyrénées, the layout of the canal system has been a determining factor in the structure of local social relations. The linear configuration of the traditional system structured linear (upstream–upstream) relations of dependence among farmers. Downstream farmers had to be sure that upstream farmers would make available the water that they needed, while upstream farmers had to count on downstream farmers to keep contributing to the maintenance of collective canal works. In our interviews, this was expressed by farmers who, referring to the traditional system, thought it came with a great deal of informal interaction (often involving mutual surveillance) between farmers. This interaction produces a stronger sense of solidarity among farmers up and down the secondary canals, as alluded to above. Our findings are similar to those of Lansing (2006), who argued that farmers in Bali self-organize and cooperate to maintain irrigation systems. Lansing posited a similar upstream–downstream dynamic, whereby farmers at higher elevation allowed sufficient water to flow to those located at lower elevation, because if they did not, pests would become a problem in the lower fields and subsequently invade those higher up. The pressurized system thus introduces a different set of social relations, because there no longer exists the previous upstream–downstream dynamic of mutual dependence. Instead, the system has the effect of individuating farmers, putting each in a relation of dependence to the centralized authority (now the ASA board of directors) who manages the pump.

Our argument that the layout of the irrigation system plays a role in structuring social relations can be illustrated in reference to Aubriot's observations on the relation between canal technology and social relations. In her early work, she argued that irrigation systems mirrored social relations and described water as 'the mirror of society' (Aubriot, 2004). More recently, however, she has paid attention to the material effects of the canal system on social relations. 'Indeed, the sharing of water, the path that it follows, has implications on the relations between irrigators. Water serves as much to bring people together as to drive them apart. It gathers and divides, separates and unites' (Aubriot, 2013: 127).

In line with Aubriot's emphasis on material effects, we stress that there is a dialectical relationship between canal structure and social relations. Social relations may change so as to affect change in the canal structure which, in turn, consolidates different social relations. For example, the exposure of agriculture in the region to global supply chains, beginning in the 1980s, increased pressure on farmers to capitalize production. As a result, they shifted to drip irrigation.

Today, pressurized irrigation and the installation of drip irrigation systems are widely acclaimed for the virtues of their efficiency by both international organizations (e.g. the Food and Agriculture Organization), the European Union, and national agencies, such as the French 'Agence de l'Eau' (Water Agency) (Venot et al., 2017). In this case, efficiency is understood as the optimal proportion between water made available through pumps and water used for agricultural production. The notion of the social efficiency of irrigation is absent. Indeed, the main argument put forward is that of satisfying the needs of the plant without producing 'waste', in an attempt to modernize agriculture (Lopez-Gunn et al., 2012). However, as E Maillol underlined during an interview, 'The [pumping] station was not [there] to save water; our objective was to make [our] life easier'. Along with the pumping stations, automatization of irrigation allowed the farmers to reduce their workload while it also lessened the upstream–downstream tensions that can arise in times of water shortage (Riaux, 2007). However, this change in practice also had secondary effects, as E Maillol observed: 'Pressurized irrigation eased some tensions, it's true; we no longer depend on our neighbours, but we don't see each other anymore either'.

Pressurized irrigation further cancels out one of water's fundamental characteristics – its weight. The weight of water explains why water always flows to the lowest point. Under the effect of pressure, it becomes possible to direct irrigation water uphill, to previously inaccessible areas. Thus, drop-by-drop irrigation has made it possible, by forcing water uphill and reducing use, 'to extend the agricultural areas irrigated' (R Majoral, 2015, personal communication). This phenomenon, also identified by Lopez-Gunn et al. (2012: 90) in their analysis of the campaign to modernize irrigation in Spain, led in some cases to a paradoxical situation: the more efficiently a resource is used, the more it is used. Thus, instead of reducing volumes of water withdrawn for irrigation, these technologies often result in increased withdrawals, which go against ecological concerns.

Discussion

Despite resolving an immediate problem, the technologies applied to reducing or eliminating what are considered the uncertainties of nature are not without effect on the social structure of the people whose lives they are meant to improve. The control of nature can often be regarded as an indirect means of controlling people. Or to put this slightly differently, as David Harvey (2010: 38) has noted, 'the exploitation of nature under capitalism often goes hand in hand with the exploitation of people'.

In this last section, we shall discuss the effects of modernity – in the form of the Vinça Dam and the pressurized irrigation systems that it made possible – on the farmers and the ASAs. Subsequently, we look into the possibilities available to the networks of irrigators to free themselves from the new constraints imposed by these developments.

Modernity: From poison to antidote

Over the centuries, farmers of the Eastern Pyrenees have developed an empirical and detailed knowledge of the land and water in the region, which allowed them to meet their needs for production in a way that co-evolved with social structure. However, with the construction of the dam, the reduction of uncertainty linked to water has tended to reduce or even deny the relevance of local knowledge that evolved in conditions of scarcity. The guaranteed availability of water produces a form of nature that corresponds to a different kind of water, a different kind of knowledge and technology, different social relations and different politics. Thus, local knowledge has further evolved in response to these

changes. With the installation of pressurized irrigation, water, which had been visible to everyone in the canals, is becoming increasingly hidden (underground in a network of pipes) and rendered abstract in the sense that it is now scrupulously measured by volume, with use and monitoring now mediated by the water meter. We thus move from primarily spatial, corporeal, proximity and knowledge of the resource to a more symbolic and socio-economic proximity, which gives rise to a different form of knowledge (Bouba-Olga and Grossetti, 2008).

Through this change in the proximity of individuals to water, the farmers become complicit in their own oppression. Indeed, drip irrigation has the virtue of making the farmer's life easier, but in exchange for the imposition of new tools to survey and quantify their use of water. These tools – namely the pump and the water meter – effect a shift in the control of water, transferring knowledge, expertise and authority from individual farms, acting as a collective, to the engineers and technocrats who master the tools in their name on behalf of the ASA. Moreover, the precondition of abundance/certainty, so necessary for the application of these tools, now makes the farmers dependent on certainty, with the possibility of its interruption rendering them insecure. For example, before the dam, farmers had a strategy of responding to the failure of early rains in April and May by abandoning the first crop of the season. Now, however, the failure of early rains provokes demands from farmers to open the dam and allow water to flow in the canals much earlier than usual, and in a manner that jeopardizes water availability later in the summer, when it is sure to be needed (e.g. Conseil Général). Such virtual crises begin to affect the social body of farmers.

In effect, the promoters of pressurized agriculture within the ASAs often think of themselves as modernizers, strongly implicated in the diffusion of knowledge about new techniques. For them, pressurized irrigation responds to the needs of farmers as well as the expectations of modern agricultural policy: (a) it puts an end to leisure time being considered as a social privilege hitherto forbidden in this profession; (b) it offers a clean, technological varnish of modernity to agriculture (Venot, 2017). However, this modernity introduces a kind of distance from water; it offers an example of what Bookchin (2016: 48) described in terms of the 'socially regressive' side of technology:

> Technology and the resources of abundance furnish capitalism with the means for assimilating large sections of society to the established system of hierarchy and authority … By their centralistic nature, the resources of abundance reinforce the monopolistic, centralistic and bureaucratic tendencies in the political apparatus. In short, they furnish the state with historically unprecedented means for manipulating and mobilizing the entire environment of life – and for perpetuating hierarchy, exploitation and unfreedom.

Water in pipes is invisible, distanced from the farmers. This distance is also in the sense that it transfers authority and control from informal relations among farmers to the ASA, which serves as an intermediary for control by the state. Thus, the ASAs as institutions, in promoting pressurized irrigation, reinforce their powers vis-a-vis the irrigators and now position themselves as guarantors of supply by means of their control over the pumping stations. They perform a kind of mediation between the individual farmers and the river, whereas the gravity-based irrigation system structured a topology of inter-individual (farmer) relationships. The conflicts that once took place immediately between the farmers along the secondary canals no longer exist. Instead, the conflict takes place at a higher level, namely between the ASAs and the Agence de l'Eau (Water Agency) and the Department.

Today the ASAs have grouped into associations of ASAs, which oppose the Department's management of the dam. For example, they go directly to the

prefect – who is a government delegate exercising executive power at the scale of the Department – to push the Department to open the dam for their immediate needs, whereas the Department more often prefers to save water for later use. Furthermore, the Water Agency applies regulations supporting environmental minimum flows, which are resisted by ASAs, arguing that the calculation of minimum flows made in the north are not pertinent in the Mediterranean zones, where streams are naturally intermittent. The ongoing conflict between ASAs and the Department manifests the process of hybridization of authority for water in the region: Neither the central government nor the local ASAs have complete control, but are rather continually evolving water policy in relation to one another. The following section describes how this evolution has affected the structure of the ASAs.

The ASAs: Malfunctions in collective institutions?

While the collective institutions work well today, two changes can be identified: (a) The forcing into modernity is experienced individually and collectively by the farmers; and (b) the ASAs have evolved gradually from institutions comprising homogeneous actors to comprising heterogeneous actors, especially as non-farmer landholders have arrived to live in these areas. These two movements challenge the historical balance and put pressure on the ASAs.

In the previous section, we mentioned the weakening of social bonds between members of the ASAs and the affirmation of its power over them. A mode of operation based on immediate, face-to-face relationships between free individuals has been replaced by a new mode that involves mediated relationships. Here, farmers must interact directly with the ASA board which means that their relationship to water is subject to mediation (Bookchin, 2016: 93). This mediation happens at two levels: it is both material – through the use of technological tools to distribute the resource and calculate used amounts of water – and political – in terms of the governance/administration of the resource by means of representation.

Material mediation acts as a catalyst, dividing the agricultural population into those capable of using and understanding the new tools and those who are unable or refuse to. As suggested by the concept of proximities put forward by Bouba-Olga and Grossetti (2008: 8), this division of the ASA members base has the effect of reducing the 'likeness or complementarity of value' between the stakeholders, and therefore fragmenting the involvement of the stakeholders within the group. Relational mediation by the ASA, for its part, participates in reducing opportunities for interaction between the stakeholders.

However, another phenomenon can be observed, which is related to newly arrived house owners – former city dwellers – who do not depend to the same degree on the water network. Rather, they become members of the ASA, because they settled in the irrigated area. The institutions that were still relatively homogenous in occupational terms, in the 1950s, comprising mainly farmers, have become more and more heterogeneous. Ladki et al. (2012) highlight this process for the Mediterranean areas of France. Indeed, they demonstrate that phases of mono-utilization were followed by phases of poly-utilization: industrial water, used by the mills in the middle ages, was eventually succeeded by the use of water for irrigation. Farmers today are experiencing such a transition again, with the arrival of more and more neo-rural residents wanting access to 'raw, untreated' canal water for use in swimming pools, garden irrigation, households, etc. (Ladki et al., 2012).

As a result, we witnessed a rupture in the 'cognitive proximity' between farmers, for whom water represents a tool for production, and the neo-rural residents who use the canal network to supplement piped, urban water. Little by little, the arrival of new residents

further complicates this cognitive proximity, which the collective institutions need in order to be able to function.

Mediation no longer takes place on the land, so an alternative is needed. General meetings of the ASAs have become the only places where members meet and have direct relationships. The committee manages all other types of relationships by way of representation.

The gradual shift from a policy of supply management to a policy of demand management and the accompanying technological changes, which we describe in our results, has transformed the nature of water as well as the social relations involved (Linton, 2010). Water has become a commodity, strictly measured by sensors on the valves on each parcel of land. The user is transformed into a consumer and the social climate becomes strained. This is illustrated with reference to relations between farmers and neo-rural residents. While, historically, the rule of representation in the ASAs was one person = one vote, the system is now shifting from one based on equality between stakeholders to the reintroduction of discrimination by possession of land. This measure introduces an existential danger to the institution of the ASA, as a system that functioned on the principle of equity and solidarity of its members and is now threatened by disparities of power, with more propertied, wealthier stakeholders having increasingly more say than smaller members.

The end of scarcity and the reconfiguration of proximity

In this article, we have attempted to show how in the 1970s, the Vinça Dam was inserted into a set of hydro-social relations that had evolved in the Eastern Pyrenees of France over many centuries. While in some ways modernizing agriculture, it can also be said that the Dam and the rules of its operation were tempered by the political and social circumstances of water governance that had long pertained in the region. As a result, neither the Dam (as an instrument of central state authority) nor the ASAs (as a locally evolved accommodation between people and water) remained pure. Instead, what has evolved is a hybrid of the local and the central, the traditional and the modern, played out in ongoing conflicts and controversies over water allocation and management.

As a further argument, we have shown how the modern shift to what we call hydrological certainty has entailed important changes in hydrosocial relations. This is predicated on Bookchin's (2016: 51) association of modern state capitalism with an engineered form of 'abundance':

> Industrial capitalism of the time of Marx organised its merchant relations around the system that prevailed then, that of material scarcity, while today's state capitalism organises them around a system of material abundance. A century ago, shortage was something that one was forced to endure; today one is forced to maintain it by coercion.

For the agricultural world, the end of (water) scarcity also marked the increasing disadvantages of small-scale agriculture. Mendras (1967) identifies this turning point in the 1960s, the period of the golden age for agriculture in the Eastern Pyrenees (Figure 5) and of studies for building the Vinça Dam. Agriculture in the Department has, we would suggest, experienced the end of resource scarcity referred to by Bookchin. This scarcity ended, in the Roussillon plain, with the construction of the dam. However, various successive water laws have rapidly and successfully put an end to this period of apparent abundance of the resource. Today, although water is potentially abundant, the actors are kept in a situation of scarcity

by a combination of taxes and rules on water use (in particular the regulations on minimum flow rates).

Today, the State (the Water Agency), by encouraging farmers to adopt pressurized technology, polices water use by virtue of the very technologies (metered flows of pressurized water) in the system. Increasingly, it is the agency who measures, controls, and orchestrates flows of water in the basin. However, this masks the interest of local farmers and ASAs in the adoption of drip irrigation. As Venot et al. (2017: 2) have pointed out, farmers often adopt drip irrigation technology for their own reasons, irrespective of the rationale of central policy makers.

A general pattern appears in the joint effect of the orchestration of affluence by pressurized irrigation and the evolution of small-scale farming. Technology has made it possible for farmers to distance themselves from water by offering them a set of tools enabling them to manage their environment (water flowing in canals) as an abstraction. In looking again at the concept of proximities of Bouba-Olga and Grossetti (2008), we interpret this distancing of the farmers from the land and from the water, and from each other, as participating in reducing the relative importance of cognitive and social resources, transforming the nature of local hydrosocial relations. Now, the personal and collective skills and attributes that give rise to the capacity to engage with one's neighbours in co-management of a common water resource-system are made redundant by the technologies of mediation, which now become the only resource-type that counts.

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Notes

1. All direct quotations of French literature have been translated by the authors.
2. All of the documents relating to the dam are kept in the Departmental Archives of the Pyrénées Orientales in Perpignan, under the reference number 1388w12.
3. Source: Departmental Archives of the Pyrénées Orientales in Perpignan, reference number 1556w37: 'Enquête préalable à la D.U.P. daté du 27 Août 1970'.

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